Insights

A publication of the Ontario Forest Research Institute

Science and Silviculture

Dr. David DeYoe, General Manager, OFRI

Silvicultural tools, methods and practices integrate principles of ecology, genetics, physiology, and other science disciplines to achieve various landowner objectives or solve resource problems. Whether the intent is to maximize fibre production, provide wildlife habitat, ensure safe and aesthetically pleasing recreational opportunities, rehabilitate degraded properties, produce veneer-grade sawlogs, or achieve some combination of these — proper silvicultural practices are key to maintaining a sustainable resource.

So how do researchers ensure that these basic science principles find their way into sound silvicultural practice? First, one must understand the forest ecosystem in question. Second, one must assess how this system responds to, and recovers from, disturbances and stresses associated with managed strategies. Third, one must design silvicultural tools and methodologies to minimize impacts of management treatments while optimizing objectives. Finally, to ensure sustainable practices, one must 'ground-truth' the tools and methods for different forest sites and conditions in order to fine-tune guidelines.

In future, OFRI will increase its efforts to work with industry to help them meet regulations set forth in the Crown Forest Sustainability Act. In conjunction with clients and partners, we are continually seeking alternatives and refinements to the resource manager tool kit to help these professionals meet management objectives, comply with resource policies, and capitalize on global markets.

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Cette publication technique n'est disponible qu'en anglais

Tracking Ontario's Trees

by Jocelyn Watt

Chris Lewis can't tell a balsam fir from a white spruce. But that hasn't stopped him from joining 2,000 other volunteers from across the province to collect data for the forthcoming *Ontario Tree Atlas*. This directory will catalogue the populations of tree species in Ontario and where they are distributed.

"I love nature," says Mr. Lewis, who lives on the shores of Lake Superior north of Sault Ste. Marie. "I'm retired, so I have lots of time. This gives me a chance to learn how to recognize different kinds of trees while I'm out walking or snowshoeing."

Each atlas volunteer is allotted a search block 10 kilometres by 10 kilometres, based on the Universal Trans Mercature (UTM) grid. Armed with definitive report forms, they will conduct tree checks for almost 100 species of tree within designated

survey squares throughout the province. The volunteers will document the presence and relative abundance of all the tree species found within their square. The information from all the volunteers will be pieced together like a giant jigsaw puzzle using GIS technology to build a portrait for each of Ontario's tree species.

The atlas is a joint project between OFRI and the University of Guelph Arboretum. Brad Graham is a gene conservation specialist with OFRI's Genetic Heritage Program, a program that works to contribute insight and direction for restoring and conserving the genetic diversity of Ontario's forests. According to Graham, Ontario has never had a comprehensive inventory of individual tree species in its forests. As a result, a particular species could become genetically threatened without forest managers being immediately aware of the problem.

"To develop specific gene conservation guidelines for Ontario's forest tree species, we must determine the status of each species: where it is located, how much of it exists, and what the biological and genetic conditions of its population are," says Graham. "Conducting this extensive survey at least gives us a snapshot of where the species are today, and how many. With that kind of information at our fingertips, we can create forest models (computer simulations) that will allow us to predict where the species will be 50 years from now. We can also recommend forest management practices to help restore forests that have become genetically eroded."

When a stand is genetically eroded, the ability of future generations of a species population to grow and survive is reduced over a long period of time. By cataloguing areas where known stands of a species grow, and creating a bioclimatic profile for that species, researchers can predict where other stands might be discovered and where new stands can be established. As well, when forest managers have access to such a profile, they can make informed decisions to keep existing populations of the species in the landscape of the area they are responsible for. They can ensure that healthy parent trees are conserved to maintain a viable gene pool.

A rich and vast pre-settlement forest

Information submitted by volunteers will be collated into a published atlas as well as a computerized database. This can be used to: establish a provincial status for each tree species, model wildlife habitat, calculate species diversity, construct bioclimatic profiles, define forest associations, and model the effects of global change. Publication date for the Ontario Tree Atlas is 1999.

For additional information, call Brad Graham, OFRI, or Rob Guthrie, University of Guelph Arboretum, (519) 824-4120, Ext. 3615.

From Forest to Wasteland to Forest

by Jocelyn Watt

A new chapter in managing southern Ontario's conifer plantations

Southern Ontario urbanites who drive the rural roadways of 'old Ontario' are accustomed to cruising past tracts of red pine planted row upon row. Few travellers are aware that these pine forests are rooted in 90 years of Ontario history. The story of southern Ontario's conifer plantations is one of ecological transitions: of reclamation, regeneration — and now restoration. OFRI scientists are contributing their expertise to a project in the Durham Region Agreement Forest that focuses on management practices that will help restore these conifer planations to a more 'natural forest'.

History of Ontario's conifer plantations: a reclamation story

The field guide to the Durham Demonstration Forest explains how a rich and vast pre-settlement forest for mixed hardwoods and white pine gave way to sterile blow sand areas spreading over a significant portion of old Ontario. It reads:

"The wastelands of Durham and other parts of southern Ontario began to form when European settlers cleared the land in the mid-1800s. The settlers, unaware that sandy soil is prone to erosion, cut nearly all the trees and farmed in ways that were hard on the land. Without trees to anchor and shade it, the topsoil was blown away by the wind or carried away by rainwater. The dry, open fields became deserts

Without trees to anchor and shade it, the soil was blown away

of shifting sand in only a few years. Unable to sustain themselves, many farmers abandoned their land."

As early as 1870, foresters, farmers and politicians began to promote the belief that trees had to be brought back to this unproductive landscape to stabilize the eroding soil and return it to a state of well-being. But it took Edmund J. Zavitz, who would become Ontario's first provincial forester, to foster the practice. Zavitz had been a lecturer at the Ontario Agricultural College at Guelph, and started a forest tree nursery there. In 1905, he began to hand out thousands of free trees to encourage reforestation. The publication of his report titled *Reforestation of Waste Lands in Southern Ontario* prompted the reclamation movement.

Gradually, large tracts of this depleted agricultural land were bought up by counties which eventually entered into agreements with the Department of Lands and Forests (now MNR) to manage the lands. The first of these Agreement Forests was established in 1922 in Simcoe County. The Durham Region Agreement Forest was added in 1931. By the 1980s, almost 107,000 hectares were under the Agreement Forest banner. Although some white pine was planted in earlier plantations, red pine, with its ability to survive in shallow sandy soils, was the conifer of choice for reclamation projects.

Succession in Ontario's conifer plantations: a regeneration story

Two waves of planting activity, one in the late 20s and early 30s, the other in the 60s, characterize these Agreement Forest plantations. Typically, the younger, unthinned plantations that are 20 to 30 years old are devoid of understory vegetation. The older plantations however, were generally thinned at 20 to 30 years of age with subsequent thinnings at 30-year intervals. As the conifer stands opened up following these silvicultural treatments, a more 'natural forest condition' began to develop. Native hardwoods and white pine began to naturally regenerate under the shelter of the plantation canopies. Residual hardwoods growing along old fencerows or in rural woodlots were the seed source for this regeneration.

"Southern Ontario's pine plantation have got a bad rap," says Eric Boysen, forester with the Southern Region Science and Technology Transfer Unit and a member of the research team. "People have referred to them as ecological deserts. This may have been true in the earlier years, but once the stands are thinned at 20 to 30 years, we start to see a resurgence in the diversity of plants and wildlife."

Boysen was present at a 1993 meeting of Southern Region foresters where the issue of succession in conifer plantation came up. He had recently visited an experimental site in the United State that was looking at changing even-aged hardwood stands to uneven-aged using canopy gap treatments. He was convinced that similar results could be obtained with conifers. Also attending the meeting was Ken Elliot, area forester for Durham North, whose profess-ional skills have been integral to the current study.

"Traditionally we had been managing these plantations to increase wood production and quality," explains Elliot. "It was acknowledged that some of the public see plantations as sterile environments that do not provide any environmental benefits other than timber production. We felt that plantations should be looked at as an early stage in the succession of open lands back to 'more native' species composition and function. To do that, we needed to know what we could do to quicken the succession process and still produce high-quality stems."

Managing succession in conifer plantations: a restoration story

OFRI hardwood silviculture researchers Dan Dey and Jim Rice helped the Durham team design a project to examine the processes that influence the quantity, quality and diversity of natural regeneration as well as the methods that would accelerate the ecological restoration of the site. The Durham Regional Forest was chosen as the experimental site since it has both younger and older plantations. Two studies were established: one in a young red pine plantation ready for its first thinning, and the second in an older plantation (originally red and white pine) ready for its fourth thinning.

In the younger plantation (established in 1962), a variety of overstory treatments including row removals, selection removals and patch clearings were implemented in the latter part of 1994. This was done to create a range of light conditions necessary for the natural regeneration to establish itself. The length of time it takes for hardwoods and other species to invade the site is being monitored. Some supplemental planting of white pine, red oak, and white ask seedlings, and sowing of red oak acorns, will allow comparison between natural and artificial regeneration methods.

The older plantation (established in 1929) is surrounded by older, hardwood trees that provide seed. Natural regeneration established in the understory is dominated by red maple, red oak, black cherry, white ash and white pine. Again, to create a range of light conditions reaching the forest floor, a variety of overstory treatments were used: normal uniform shelterwood, and large and small canopy gaps. According to OFRI's Jim Rice, past shelterwood thinnings haven't always provided enough light to allow for healthy, vigorous, young trees with good form. To encourage straighter, higher quality stems, understory coppicing (cutting of stems at ground level and allowing new stems to grow) was undertaken in a number of the trial blocks.

"Overstory thinning patterns were overlaid with coppicing of advanced natural regeneration," explains Rice. "Cutting of the young stems allows a new sprout to emerge and grow quickly. The increased overhead light from the thinning should allow fast, straight growth of the new stems. Growth of over 2 metres in the first year is not uncommon."

Researchers are also conducting soil sampling and vegetation occurrence surveys to monitor changes in soil chemistry and plant species diversity.

How can forest managers use this research?

At the Durham research site, the primary goal is to develop knowledge that can be used to restore red pine plantations to diverse 'native forests'. Ultimately, a silvicultural guide will be produced to aid forest managers in meeting this goal by providing such information as:

- the most effective overstory disturbance patterns to promote desirable regeneration.
- the best disturbance patterns to produce desirable species distribution, stocking levels and density of regeneration.
- the role played by supplemental planting and seeding.
- the disturbance patterns that most effectively release established regeneration and develop healthy, high-quality trees.
- the effectiveness of coppice treatments to increase understory quality, vigour and density.
- the changes that take place in soil nutrient composition over the conversion period.
- the species diversity changes that take place over the conversion period.

Establishment Report and Durham Demonstration Forest literature available from Ken Elliot, Vivian Work Centre (905) 473-2160. Extension Notes available from Eric Boysen, Science and Technology Transfer Unit, Southern Region (613) 258-8240. Research information available from Dan Dey or Jim Rice, OFRI. Industry cooperators include two area contractors, Miller Lumber and Conifer Farms.

Anthropogenic Fire

by Jocelyn Watt

A new perspective on the fire/oak connection

It's not news that forest management practices such as prescribed burning can alter the environment to favour specific species. But current research initiated by OFRI's Dan Dey is using a unique dating system to document long-term fire histories in red oak stands. By examining old fire scars and using sophisticated demdrochronology methods, researchers are able to establish site-specific fire chronologies that in some cases date back to the early 17^{th} century. These chronologies can then be cross-referenced with recorded human events that would have influenced fire frequency. Such information will provide a broader context for determining effective fire prescriptions for managing red oak sites in Ontario.

"It's not enough to just go in and burn," comments Dey. "If we are to better understand the natural order, we have to look to the past for clues as to what ecological role fire has played in the evolution of the forest. We have to understand the historical frequency and intensity of burns in the past so that we can apply that knowledge to silvicultural planning. Fire incidence has changed over time and so has the forest in response to those burning cycles. We're documenting that."

In an initial fire history study, Dey and University of Missouri dendrochronologist Richard Guyette compiled a fire chronology for a red oak stand in the Bancroft District. Cross-sections were taken close to

Pre-harvest understory burn to promote red oak

ground level and examined to determine the dates of fire scars, periods of regeneration, and significant events that took place during stand development such as growth releases and suppression.

The researchers found that regeneration of red oak at the site occurred from the early 1800s to the 1920s, a period characterized by frequent fire disturbances. These short, fire-free intervals favoured the development of red oak advanced reproduction by limiting the development of the less fire-resistant, shade-tolerant species in the understory. There was no evidence of fire after 1995. This absence of fire has led to the dominance of shade-tolerant species in the understory, leading researchers to believe that fire suppression and the consequent loss of oak may result in a reduction of both economic and biodiversity values on these sites.

"Oak seedlings need light and cannot tolerate being suppressed for long periods," says Dey, "whereas species such as sugar maple are shade-tolerant. It's pretty conclusive that fire favours red oak by releasing advance reproduction from its competition. Fire is also an alternative to herbicides."

Old pines pinpoint past

One drawback to using *live* trees to track fire occurrence is that many of our forest are second-growth and often less than 50 years old. Researchers discovered that they could extend fire histories back even further by examining *dead* trees. During a search for suitable study sites, Bancroft District forester Bruce Fleck pointed out that many of the old-growth pine stumps and snags present in red oak stands were internally sound enough to allow growth ring analysis, even though they were badly decayed on the outside.

By incorporating these old growth pine stumps and snags into their research, Dey and Guyette could now date fire histories back to the early 17th century. They created a *master tree ring chronology* for red and white pine from core samples taken from live pines located in specific stands throughout central Ontario. Researchers now had a tool that allowed them to correlate fire occurrence to pre-settlement events.

For example, in the oak-dominated forest in the Bracebridge area, researchers estimated that old growth white pine stands had been harvested over 100 years ago. By examining fire scars on cross-sections of remnant stumps, using dendrochronological methods to date them, and using the master tree ring chronology, they were able to establish a fire record that spanned a period from 1664 to 1852. This fire history could now be correlated to events in human history.

The aboriginal connection

Traditionally, fire occurrence has been attributed to natural causes such as lighting, or to the logging and farming practices of early settlers. One interesting hypothesis Dey is pursuing is the idea that aboriginals living in Ontario long before Europeans came here had a more profound effect on fire-regenerated forests than previously acknowledged. Early North American Natives used fires to manipulate the environment to their advantage. Fire was used for hunting, increasing browse for animals, managing the production of berries, conducting warfare, and for agricultural purposes. During the 17th century, Native populations were drastically affected by inter-tribal relations, the fur trade, disease epidemics, and changing economies. So far, Dey has been able to document a relationship between these historical events and subsequent fire frequencies that have influenced the development of 7 red oak and pine stands in central Ontario.

In the Bracebridge study for instance, the site was located on the Muskoka River, a major travel route for natives and European explorers. Historical Native occupation of the site had already been documented. The area was initially inhabited by

the Hurons, but by the mid-17th century, epidemics and invasions by the Iroquois produced a largely transient population.

The change from traditional Huron occupation of the study area to transient use coincides with a period of relatively low fire frequency (1664 to 1740). From 1740 onward, reoccupation of the study area by Natives and European fur traders could account for the observed increase in the frequency of fire between 1741 and 1810. This later, frequent fire pattern, Dey suggests, likely advanced the regeneration of red oak, accounting for its present dominance in the overstory.

"Our forests have developed over eons of time," muses Dey. "Maybe we're better off to understand and simulate those processes rather than to drastically alter natural disturbance regimes which may initiate successional pathways that make it hard or expensive to achieve desired forest conditions."

How can forest managers use this research?

Results from this research will:

- provide insight for the development of silvicultural practices for regeneration of fire-dependent ecosystems.
- be used to develop management techniques that better mimic natural ecosystem processes.
- establish a basis for conserving and restoring old growth pine and other fire-dependent ecosystems throughout Ontario.
- provide a regional database of fire regimes that can be used in the development of landscape-level models.

For more information, or research reports, contact Dan Dey, OFRI.

Research in the Regions

Northeast Region: ***Sheep grazing affects site vegetation***

by Lisa J. Buse and Wayne Bell

Sheep grazing has been tested as an alternative to using herbicides for conifer release since 1991. The intent is to define site conditions where sheep are an effective alternative and to determine how best to use sheep for forest vegetation management. Initially, staff at the Northeast Science and Technology Unit in Timmins, in cooperation with Abitibi-Price Inc.


Sheep grazing a forest plantation

and Superior Forest Management Ltd., focused on the operational aspects of managing sheep in the forest and on crop tree response to the treatments. More recently, the successional patterns that followed grazing (compared to those of other vegetation management treatments) have sparked the interest of Wayne Bell, OFRI scientist, and Steve Newmaster, Superior Botanical Explorations.

Vegetation data collected on the 1995 sheep grazing project is showing some interesting results. In the summer of 1995, 450 sheep grazed on 27.5 hectares just east of Timmins, Ontario. According to Newmaster, bryophytes were almost non-existent after grazing. The hooves of the sheep loosened the soil and destroyed bryophytes, lichens, and smaller herbs. On the other hand, several plant species quickly reinvaded the area: bracken fern, spreading dogbane, blueberry, and pin cherry. In addition, some grasses previously not present were found on the site: old panicgrass, tickle grass, and Kentucky bluegrass. These are most likely imports, compliments of sheep dung. The non-native species will be monitored to see how they compete with the indigenous species.

Although these results are only preliminary and the possibility that these species are coming from adjacent ditches exists, Bell cautions that the possible introduction of non-native species to forested areas through the use of sheep as a vegetation management tool needs to be considered in future research and development work. Invading vegetation may be more competitive than native species or may change the ecology of the site.

"I would recommend that forest managers try to use local feed supplies rather than feed from the prairies or from southern Ontario," says Bell. "This would reduce the chance of importing noxious weeds into the boreal forest."

For more information, contact Wayne Bell, OFRI.

Northwest Region: *Controlling spruce budworm defoliation in seed orchards*

by Lisa J. Buse

Eastern spruce budworm is one of the most common and destructive pests in seed orchards in Ontario. High budworm populations defoliate the trees, reducing their vigour and potential cone production. In the past, chemical insecticides such as dimethoate were used to control budworm in these areas. OFRI researchers, in cooperation with scientists from the Canadian Forest Service, are evaluating a botanical insecticide called *azadirachtin* for controlling spruce budworm defoliation in seed orchards. Researchers hope that this will prove an effective, environmentally sound alternative to chemical insecticides.

Azadirachtin is a seed extract from the tropical neem or margosa tree. It can be sprayed onto the foliage just like a conventional insecticide, or injected into the tree using capsules. Both methods are being tested in the laboratory under controlled conditions and at the Aubrey Seed Orchard near Dryden. According to Kevin Wanner, a pest management specialist at OFRI, the use of neem seed extract results in 30% less defoliation, less severe damage to defoliated shoots and 70% fewer budworm in treated areas. Both foliar and systemic applications of neem seed extract successfully protected white spruce from budworm defoliation.

Although there are some disadvantages to consider, not the least of which is that neem extract is not currently registered for use in Canada (efforts to obtain registration are underway), other potential uses for this botanical insecticide include high value forests and urban environments, where public concerns preclude the use of conventional insecticides.

For more information, contact Tim Meyer, OFRI.

Southern Region: *Incorporating growth and yield data into a study of rare warblers*

by Abby Obenchain

Over the past 5 years, the Ontario Forest Growth and Yield Program, coordinated by OFRI and the regional Science and Technology Units, has been establishing a network of permanent sample plots across the province. This network is enabling the MNR to monitor not just tree growth but also other values such as vegetation, soils and wildlife habitat. Program staff around the province are developing a variety of linkages with forest and wildlife researchers. In the Southern Region, for example, staff have linked with Queen's University researchers who are studying the habitat requirements and nesting behaviour of the cerulean warbler, a bird officially listed as *rare* in Ontario.

"The results so far are very exciting," says lead researcher Catherine Oliarnyk, a graduate student at Queen's. "The cerulean is the fastest-declining migrant warbler species in North America, although it is abundant locally and doing very well in our study sites in the Frontenac Axis Region near Kingston. At least 80% of nests in the study area produced and fledged a minimum of 1 offspring in 1995."

According to Oliarnyk, this region provides a summer home to most of the cerulean warblers in Canada — an estimated 89 breeding pairs per square kilometre. This nesting success is likely due to the large area of mixed deciduous forest that blankets the region.

"These birds appear to prefer nesting in the interior of large forests near the tops of large trees with a diameter at breast height of 30 to 40 cm or greater," she says. "While the species of hardwood tree doesn't seem to matter, the majority of nests in the study areas were in sugar maple or oak species."

She points out that nests protected by a large buffer of forest are less likely to be taken over by the brown-headed cowbird, an edge-dweller that lays its eggs in the nests of other birds and has contributed to the decline of several songbird species in North America (their exact role in the decline of songbirds in Ontario is uncertain).

Along with MNR researchers, Oliarnyk will develop management recommendations for the cerulean warbler using data collected from her 3 study sites as well as data collected by the Forest Growth and Yield Program growth plots on the sites. These recommendations will likely include protecting large tracts of mature forest, although first-year results indicate that light thinning of pole and sawtimber did not affect breeding success.

According to Tim Williams, Growth and Yield project forester with the MNR's Southern Region Science and Technology Unit, long-term bird habitat monitoring and the creation of habitat supply models are important objectives for the Forest Growth and Yield Program in southern Ontario. Funding for the program is provided by the MNR. Oliarnyk's research is funded by the Eastern Ontario Model Forest.

For more information, contact Catherine Oliarnyk, Department of Biology, Queen's University (613) 545-6140, or Tim Williams, STTU Brockville, (613) 342-8524

Central Region: ***Assessing plantation ecology***

by Dorothy Gillmeister

Global climate changes, skyrocketing population pressures on forested areas, and society's continuing reliance on wood products combine to present special challenges for forestry in the 21st century. It will be more important than ever to balance the monetary and ecological costs of various forestry practices. Making efficient use of *prime sites* is the key to maintaining biodiversity as well as productivity in the future.

Growing genetically selected *best strains* of desirable species in intensive plantations on good sites can provide large amounts of timber of high quality and uniformity. High yields from these plantations will shift the pressure for wood production off other sites, which can then be managed to promote biodiversity, genetic conservation, natural habitat preservation, and other long-range strategies.

OFRI scientist Chris Papadopol believes that by incorporating the most modern technology available into current plantation management techniques, we can devise efficient methods of timber production that are also easy on the environment.

"By concentrating intensive plantations on prime areas, we will be able to spare more of the natural ecosystems," Papadopol explains. "Because prime sites are very rich in nutrients, we also lessen the danger of damaging the environment ."

In the late 1920s, plantations were set up in the Kirkwood Forest (near Thessalon) to test the performance of a variety of species in comparison with natural stands, and to determine the extent of potential differences. Since 1993, nine weather stations have been measuring air temperature, soil temperature, relative humidity at various elevations, solar radiation, wind speed and precipitation. Other stations monitor soil moisture at 7 depths each. Sap flow and tiny stem diameter variations are monitored every 10 minutes. Very reliable estimates of evapotranspiration (the atmospheric demand for evaporation from tree crowns) are derived from this data. This information is critical for assessing short-term moisture needs.

Preliminary results suggest that red pine, a species recommended for sandy sites, may not be the wisest choice for the deep, coarse, sandy soils typical of the area, with their limited soil water reserve. These permeable soils lose water quickly; even in a season of above-average precipitation, only 2 weeks without rain will leave them parched. After a dry interval, dense forests will sustain severe damage; only with special tending techniques to moderate the impact of such conditions can the trees reach their potential.

"In comparison with some deeply rooted, valuable hardwoods of this area, red pine is not the best choice, given the conditions that may be created by climate change," says Papadopol. "These forests will survive only with periodic density control through thinning, because any increase in temperature will accentuate soil water stress. For these plantations, thinning treatments at 8- to 10-year intervals are essential."

Red pine does better on finer, shallower sand where the ground water or its capillary fringe is accessible to the roots.

"In the future, we could increase the productivity of these deep sandy sites through greater use of species which are able to retrieve water from a depth of 8 to 10 metres," suggests Papadopol. "Northern red oak and european larch are good possibilities currently being tested."

This trial will continue to the end of the century. Definitive results can be expected by 1998, but the longer the research period, the more valuable the results will be for guiding the future management of intensive plantations.

"It's a matter of how many dramatic episodes you can catch," Papadopol says. "It is important to catch extreme variations, to show how far species can go in withstanding unusual water stress and still manage to remain green."

For more information, contact Chris Papadopol, OFRI.

Have a suggestion?
Want more information on a research project?
We want to hear from you!

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